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SECTION 32 PROGRAM. STREAMBANK EROSION CONTROL EVALUATION AND D--ETC(U)
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SECTION 32 PROGRAM. STREAMBANK EROSION CONTROL EVALUATION AND DEMONSTRATION WORK UNIT 4-RESEARCH ON SOIL STABILITY AND IDENTIFICATION OF CAUSES OF STREAMBANK EROSION.

EVALUATION OF SPRAY-ON STABILIZERS FOR BANK PROTECTION,

by

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Investigation Report 1

Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

038100 JOB

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FOREWORD

The investigation reported herein was conducted under Section 32 of the Water Resources Development Act of 1974, Public Law 93-251. Five materials were tested and two, Aerospray 70 and Soil Seal, proved effective in aiding vegetation to be established on denuded slopes.

SECTION 32 PROGRAM

STREAMBANK EROSION CONTROL EVALUATION AND DEMONSTRATION

WORK UNIT 4 - RESEARCH ON SOIL STABILITY AND

IDENTIFICATION OF CAUSES OF STREAMBANK EROSION

EVALUATION OF SPRAY-ON STABILIZERS FOR BANK PROTECTION

1. During construction and/or repair of stream embankments, large upper streambank areas are stripped of their natural vegetation. This investigation was directed toward protection of these denuded areas from erosion by wind and rainfall until vegetation can be established. Five spray-on type materials were examined to determine if they were capable of controlling erosion during this period without having an adverse effect on the reestablishment of vegetation.

2. The materials examined included four made in the United States and one material furnished by the U.S.S.R. The materials and a brief description are listed below:

- a. Aerospray 70 (U. S.) - a polyvinyl acetate, latex water emulsion that cures into a durable surface film.
- b. Soil Seal (U. S.) - a copolymer emulsion of acrylate and methacrylates that also cures into a durable surface film.
- c. DLR (U. S.) - an acrylic that forms a thin hard surface.
- d. Peneprime (U. S.) - a penetrating grade of cutback asphalt that penetrates into the soil and leaves a tough hard surface.
- e. Nerozin (U.S.S.R.) - a dark brown fluid that is based on resin from the semichoking of fuel shale and caustobioliths (lignite, peat, etc.) and has adhesive properties.

3. Test plots using these materials were constructed on flat and sloping areas. Five test plots and a control plot were constructed on a flat area, and ten test plots and a control plot were constructed on a 1 vertical on 4 horizontal slope. Figure 1 gives the layout of these plots, and Table 1 lists the area of each plot, stabilizer used, application rate, and dilution. The five test plots on the flat area were divided into three equal sections. Section one of each plot (e.g. B_1) was sprayed at the manufacturer's recommended rate; section two (e.g. B_2)

at 1-1/2 times the manufacturer's recommended rate; and section three (e.g. B_3) at the manufacturer's recommended rate but also fertilized and seeded. On the slope, two plots were constructed using each stabilizer. One was sprayed at the manufacturer's recommended rate and the other at 1-1/2 times that rate. Each test plot on the slope was divided into two equal sections, and the section designated by subscript 2 (e.g. F_2) was fertilized and seeded.

4. Bermuda grass seed at the rate of 205 kg/ha (200 lb/acre) and 13-13-13 fertilizer at the rate of 410 kg/ha (400 lb/acre) were applied to the seeded sections of these plots immediately prior to spraying the stabilizer. These plots were monitored from 24 April to 22 June 1978.

5. During this monitoring period, climatic data were collected using an automated field station with a digital recorder. Parameters selected for collection included rainfall, relative humidity, wind length and direction, air temperature, solar radiation, and soil temperatures at surface and 5 cm (2 in.) deep. These parameters were selected to determine all the relationships, direct and indirect, between climate requirements and germinations and growth of Bermuda grass. As expected, the field station provided a substantial amount of data. Table 2 is a summary of temperature and rainfall data, and Figures 2-7 are samples of the type data that occurred day after day. Magnitudes changed to some extent, but these are the recognizable patterns that occurred throughout the monitoring period. The complete series of these data are not included herein but are available to others wishing to examine the results more closely. In addition to the data collected by the field station, visual inspections were made daily and photographs were taken periodically.

6. The initial series of photographs was taken on 24 April 1978. The plots, at this time, had sustained only 12.7 mm (0.5 in.) of rainfall. The second series of photographs was taken on 11 May 1978. During this time frame of three weeks, the plots had sustained a total rainfall of 221.7 mm (8.7 in.). On 22 June 1978, the final series of photographs was taken, and at this time, the plots had sustained a total rainfall of 306.0 mm (12.0 in.).

7. Figures 8-23 show the seed portion of the test plots as they appeared on 24 April, 11 May, and 22 June. The following paragraphs discuss the effectiveness of the test materials.

Aerospray-70

8. Aerospray-70 was applied on the slope at rates of 0.122 and 0.183 ℓ/m^2 (130 and 195 gal/acre). The two plots are shown in Figures 8 and 9, respectively. Examination of the photographs taken on 11 May reveal that rills of 10 to 20 cm (4 to 8 in.) had formed outside the test plots. Sloughing was apparent in both plots, but no rills had formed in the plots. The 11 May photographs also reveal that plant emergence is greater in the plot having the lighter application. This deficiency was only temporary as noted in photographs taken on 22 June. At this time, plant emergence and growth rate were approximately equal in both plots. These sections appeared to be equally effective in controlling erosion.

9. Plant emergence and growth rate using Aerospray-70 at 0.122 ℓ/m^2 (130 gal/acre) in the flat area were poor (Figure 10) but better than in the control plot. Plant emergence and growth rate were poorer for all plots on the flat area than for those located on the slope. This may be due to the difference in nutrients in the soil. No other conclusions could be drawn.

Soil Seal

10. Soil Seal was applied at rates of 0.041 and 0.061 ℓ/m^2 (45.0 and 67.5 gal/acre). The two plots on the slope are shown in Figures 11 and 12, respectively. Plant emergence was good but slow. Once the plants had emerged, growth rate was good. The growth rate was greater in the plot having the greater application rate. In the flat area, the plot stabilized with Soil Seal (Figure 13) had very poor plant emergence and plant growth. Soil Seal appears to be a very effective stabilizer. Very little erosion took place within the plot while the area outside the plots was badly eroded.

Nerozin

11. Nerozin was applied at the recommended rate of 0.297 ℓ/m^2 (320 gal/acre) and also at 1-1/2 times that rate or 0.448 ℓ/m^2 (490 gal/acre). Figures 14 and 15 show these plots as they appeared throughout the observation period. Neither plot on the slope was effective in maintaining stability of the soil particles to allow vegetation to be established. This may be due in part to the small quantity of the undiluted material recommended to cover the test plot. Also little or no benefit was realized when the recommended application rate was increased by 1-1/2 times. Total uniform coverage of the plot was difficult to achieve at these application rates. Photographs taken on 11 May reveal 10- to 20-cm (4- to 8-in.) rills and very little established vegetation in either plot. Very few Bermuda grass seeds germinated in the Nerozin plot on the flat (Figure 16). Most of the vegetation shown in Figure 16 is volunteer vegetation.

Peneprime

12. Peneprime was applied at rates of 0.896 and 1.344 ℓ/m^2 (958 and 1437 gal/acre). The two plots on the slope are shown in Figures 17 and 18, respectively. Plant emergence was slow in both plots and lighter in the plot having the heavier application rate. This light emergence also took place in the plot located in the flat area (Figure 19). This may be due to the hard crust formed by the heavy application of the undiluted material. Plants that did emerge appeared to have a fair growth rate. Erosion in the form of sloughing took place in both plots on the slope but appeared to be greater in the plot having the heavier application (1.344 ℓ/m^2 (1437 gal/acre)).

DLR

13. DLR was applied at rates of 0.041 and 0.061 ℓ/m^2 (45.0 and 67.5 gal/acre). Figures 20 and 21, respectively, show these plots

during the observation period. Plant emergence and growth rate were good in all plots including the plots in the flat area (Figure 22). Plots on the slope sustained a high degree of erosion. Rills of 15 to 20 cm (6 to 8 in.) formed in the plots, and sloughing was very evident.

Control Plot

14. The control plot on the slope (Figure 23) indicates the results of seeding without using a stabilizer. Very little vegetation has been established in the plot, and rills of 15 to 20 cm (6 to 8 in.) were evident.

Discussion and Conclusions

15. This investigation clearly indicated the advantages of using spray-on stabilizers on denuded slopes until vegetation becomes established.

16. Three of the materials tested, Aerospray-70, Soil Seal, and DLR, were effective in establishing vegetation. These materials showed no adverse effect on germination. Bermuda grass in these sections emerged and propagated better than that in the control plot. Aerospray-70 and Soil Seal were the most effective in controlling soil erosion during the test period. The plant emergence and growth rate using Peneprime and Nerozin were below that obtained in the control plot. In conclusion, it is recommended that Aerospray-70 and Soil Seal be incorporated into some of the Section 32 Program demonstration projects for field testing. It is also recommended that spray-on stabilizers be considered for general use to inhibit erosion while enhancing plant emergence and early growth. General guidelines for application of spray-on stabilizers are given in Appendix A; further studies on various types of soils subject to different conditions may show more effective application procedures.

Table 1

Application and Dilution Rates
for Stabilizers, Fertilizer, and Seed

Section	Area m^2	Area ft^2	13-13-13 Fertilizer lb	Bermuda Seed lb	Dilution Stabilizer to Water	Stabilizer	Application Rate ℓ/m^2	Application Rate gal/acre
A	25	269	2.42	1.08	--	Control	--	--
B_1	25	269	0.00	0.00	1 to 10	Aerospray	0.122	130.0
B_2	25	269	0.00	0.00	1 to 10	Aerospray	0.183	195.0
B_3	25	269	2.42	1.08	1 to 10	Aerospray	0.122	130.0
C_1	25	269	0.00	0.00	1 to 10	Soil Seal	0.041	45.0
C_2	25	269	0.00	0.00	1 to 10	Soil Seal	0.061	67.5
C_3	25	269	2.42	1.08	1 to 10	Soil Seal	0.041	45.0
D_1	25	269	0.00	0.00	--	Peneprime	0.896	958.0
D_2	25	269	0.00	0.00	--	Peneprime	1.344	1437.0
D_3	25	269	2.42	1.08	--	Peneprime	0.896	958.0
E_1	25	269	0.00	0.00	--	Nerozin	0.297	320.0
E_2	25	269	0.00	0.00	--	Nerozin	0.448	480.0
E_3	25	269	2.42	1.08	--	Nerozin	0.297	320.0
Q_1	25	269	0.00	0.00	1 to 10	DLR	0.041	45.0
Q_2	25	269	0.00	0.00	1 to 10	DLR	0.061	67.5
Q_3	25	269	2.42	1.08	1 to 10	DLR	0.041	45.0
F_1	22.5	241	0.00	0.00	1 to 10	Aerospray	0.122	130.0
F_2	22.5	241	2.17	0.96	1 to 10	Aerospray	0.122	130.0
G_1	22.5	241	0.00	0.00	1 to 10	Aerospray	0.183	195.0
G_2	22.5	241	2.17	0.96	1 to 10	Aerospray	0.183	195.0
H_1	22.5	241	0.00	0.00	1 to 10	Soil Seal	0.041	45.0
H_2	22.5	241	2.17	0.96	1 to 10	Soil Seal	0.041	45.0
I_1	22.5	241	0.00	0.00	1 to 10	Soil Seal	0.061	67.5
I_2	22.5	241	2.17	0.96	1 to 10	Soil Seal	0.061	67.5
J_1	22.5	241	0.00	0.00	--	Nerozin	0.297	320.0
J_2	22.5	241	2.17	0.96	--	Nerozin	0.297	320.0

(Continued)

Table 1 (Concluded)

Section	Area m^2	Area ft^2	13-13-13 Fertilizer lb	Bermuda Seed lb	Dilution Stabilizer to Water	Stabilizer	Application Rate ℓ/m^2	Application Rate gal/acre
K_1	22.5	241	0.00	0.00	--	Nerozin	0.448	480.0
K_2	22.5	241	2.17	0.96	--	Nerozin	0.448	480.0
L_1	22.5	241	0.00	0.00	--	Peneprime	0.896	958.0
L_2	22.5	241	2.17	0.96	--	Peneprime	0.896	958.0
M_1	22.5	241	0.00	0.00	--	Peneprime	1.344	1437.0
M_2	22.5	241	2.17	0.96	--	Peneprime	1.344	1437.0
N_1	22.5	241	0.00	0.00	1 to 10	DLR	0.041	45.0
N_2	22.5	241	2.17	0.96	1 to 10	DLR	0.041	45.0
O_1	22.5	241	0.00	0.00	1 to 10	DLR	0.061	67.5
O_2	22.5	241	2.17	0.96	1 to 10	DLR	0.061	67.5
P	45	482	4.34	1.92	--	Control	--	--

Table 2

Summary of Temperature and Rainfall

Date	Air Temperature, °C Maximum	Minimum	Precipitation, mm Observation Period	Total*
27-4-78	20.6	6.1	0.0	12.7
28-4-78	24.4	7.2	0.0	12.7
29-4-78	26.7	13.9	0.0	12.7
30-4-78	26.7	17.2	0.0	12.7
1-5-78	27.8	19.4	5.1	17.8
2-5-78	27.8	13.3	2.5	20.3
3-5-78	20.6	13.3	33.0	53.3
4-5-78	21.1	11.4	12.2	65.5
5-5-78	17.8	7.2	0.0	65.5
6-5-78	24.4	12.2	0.0	65.5
7-5-78	23.3	16.7	76.2	141.7
8-5-78	24.1	19.4	22.9	164.6
9-5-78	23.3	17.5	21.3	185.9
10-5-78	28.3	11.9	0.0	185.9
11-5-78	28.8	15.6	35.8	221.7
12-5-78	29.2	18.3	0.0	221.7
13-5-78	28.3	15.0	24.6	246.3
14-5-78	25.0	11.7	0.0	246.3
15-5-78	27.2	16.1	0.0	246.3
16-5-78	28.3	15.0	2.0	248.3
17-5-78	22.2	14.4	8.6	256.9
18-5-78	25.6	16.1	4.8	261.7
19-5-78	31.1	19.4	0.0	261.7
20-5-78	30.0	20.0	0.0	261.7
21-5-78	32.2	20.0	0.0	261.7
21-5-78	31.7	18.9	8.1	269.8
23-5-78	31.7	19.4	0.0	269.8

(Continued)

* Prior to instrumentation, but after preparation of test plots, the plots sustained 12.7 mm of rainfall.

Table 2 (Concluded)

Date	Air Temperature, °C Maximum	Minimum	Precipitation, mm Observation Period	Total*
24-5-78	30.6	20.0	0.0	269.8
25-5-78	31.1	19.4	0.0	269.8
26-5-78	34.4	18.3	0.0	269.8
27-5-78	32.8	20.6	0.0	269.8
28-5-78	33.3	21.7	0.0	269.8
29-5-78	31.1	21.1	0.0	269.8
30-5-78	30.6	20.6	4.3	274.1
31-5-78	31.1	18.9	0.0	274.1
1-6-78	31.7	19.4	0.0	274.1
2-6-78	31.1	20.0	6.3	280.4
3-6-78	26.7	20.0	0.0	280.4
4-6-78	27.7	18.9	0.0	280.4
5-6-78	29.4	18.9	0.0	280.4
6-6-78	31.7	20.0	0.0	280.4
7-6-78	29.4	22.8	0.0	280.4
8-6-78	28.3	21.7	21.8	302.2
9-6-78	28.6	17.5	1.3	303.5
10-6-78	27.8	15.6	0.0	303.5
11-6-78	30.0	18.3	0.0	303.5
12-6-78	31.1	24.4	0.0	303.5
13-6-78	34.4	22.8	0.0	303.5
14-6-78	31.7	15.6	0.0	303.5
15-6-78	29.4	13.3	0.0	303.5
16-6-78	31.7	18.3	0.0	303.5
17-6-78	31.6	22.2	0.0	303.5
18-6-78	32.8	22.2	0.0	303.5
19-6-78	32.8	22.2	0.0	303.5
20-6-78	31.1	20.6	2.5	306.0
21-6-78	31.7	21.1	0.0	306.0
22-6-78	33.9	21.6	0.0	306.0

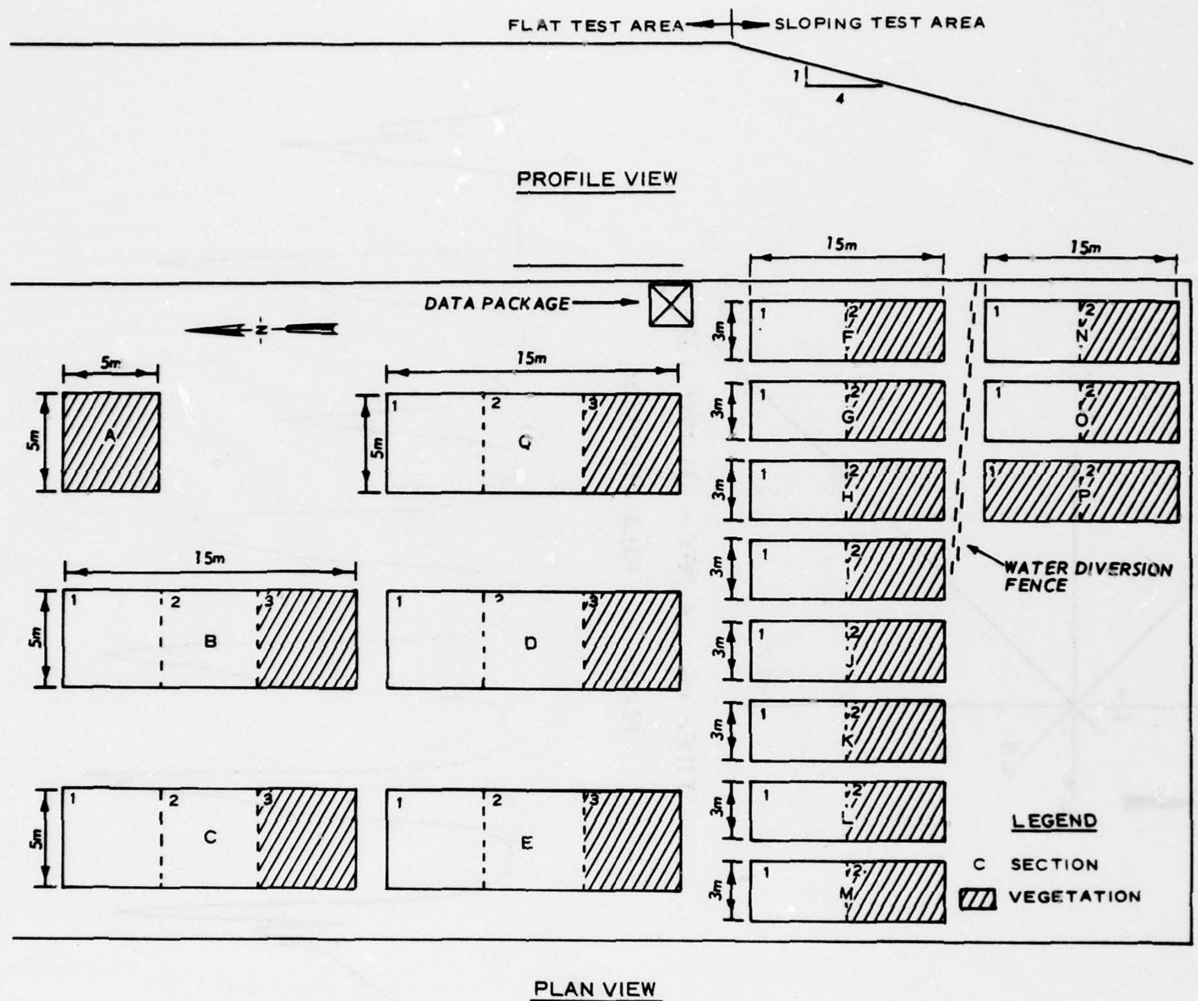


Figure 1. Layout of the test plots

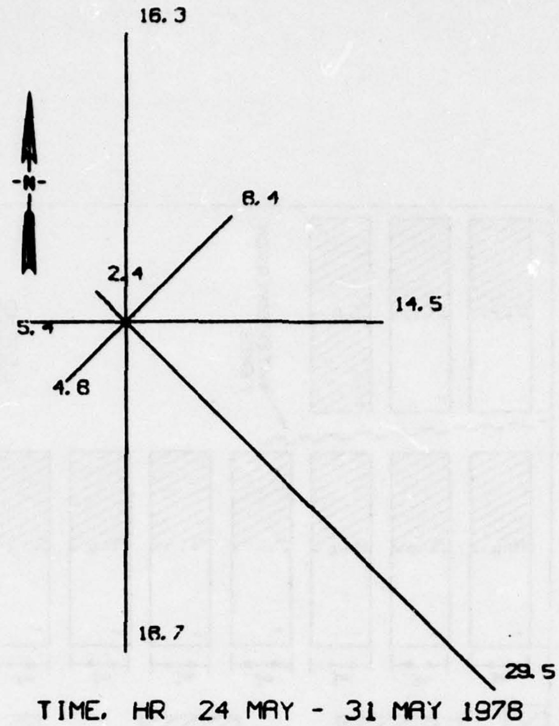


Figure 2. Wind direction

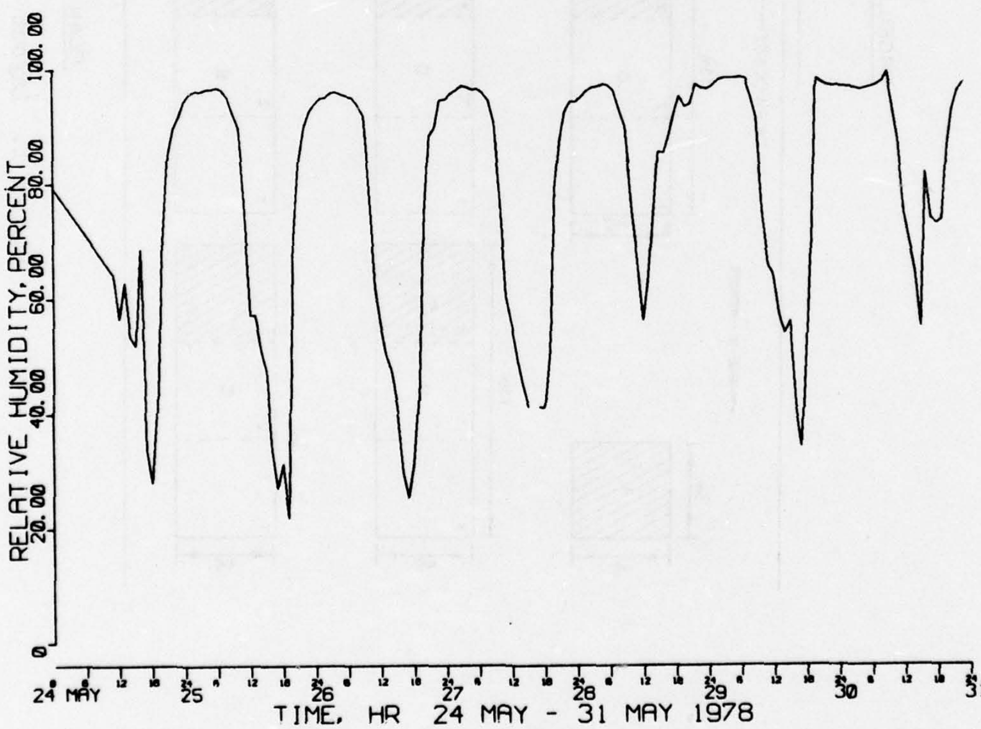


Figure 3. Relative humidity

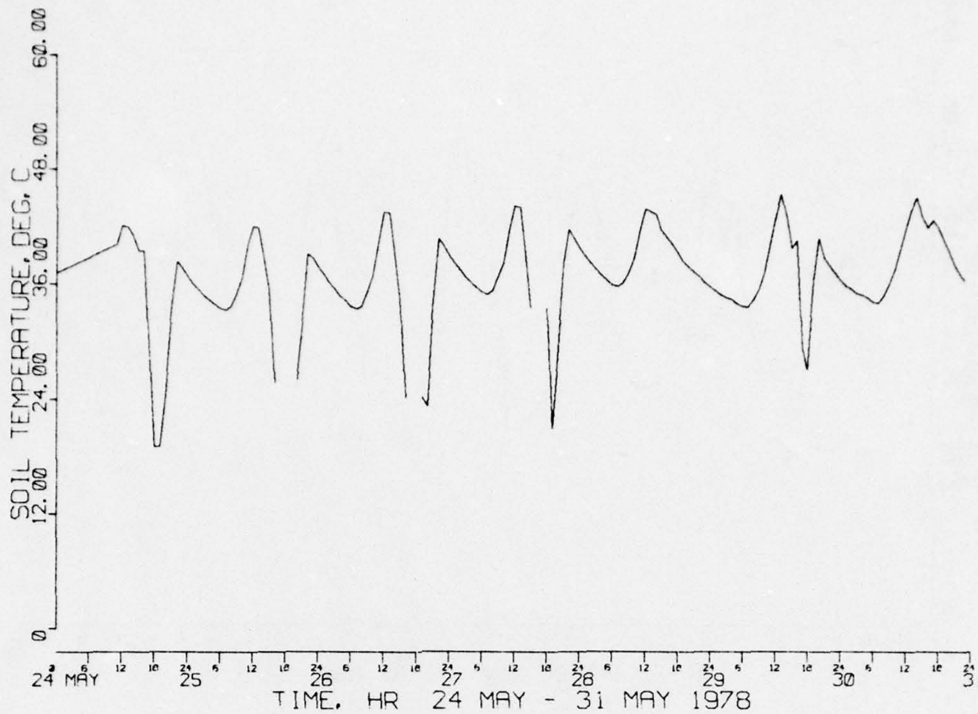


Figure 4. Soil temperature at 5 cm (2 in.), plot F (sample)

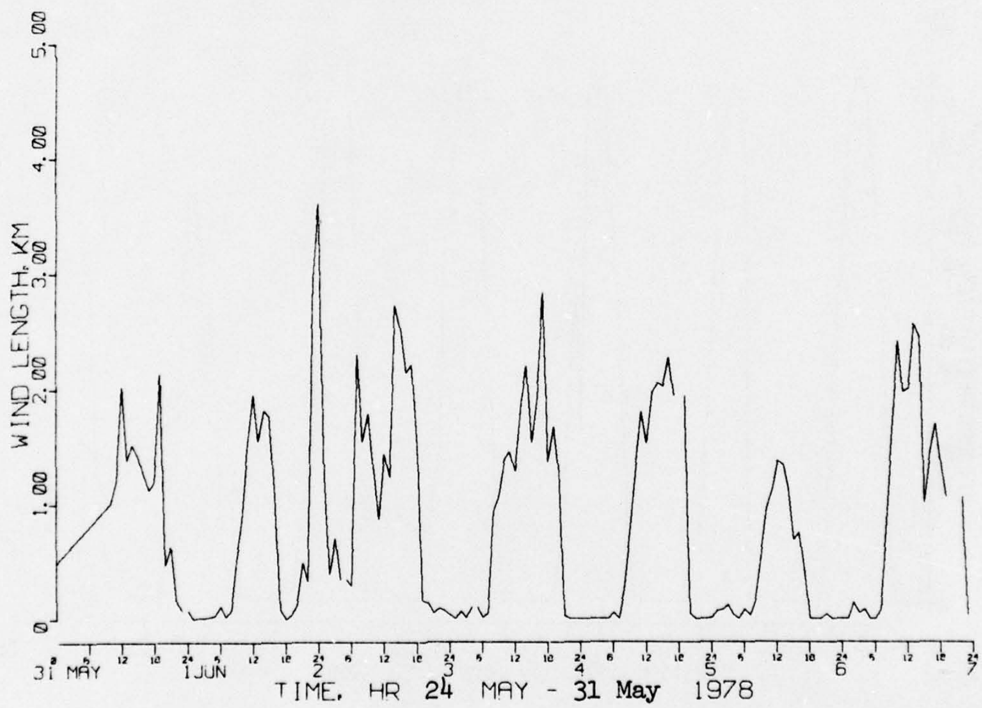


Figure 5. Wind length (sample)

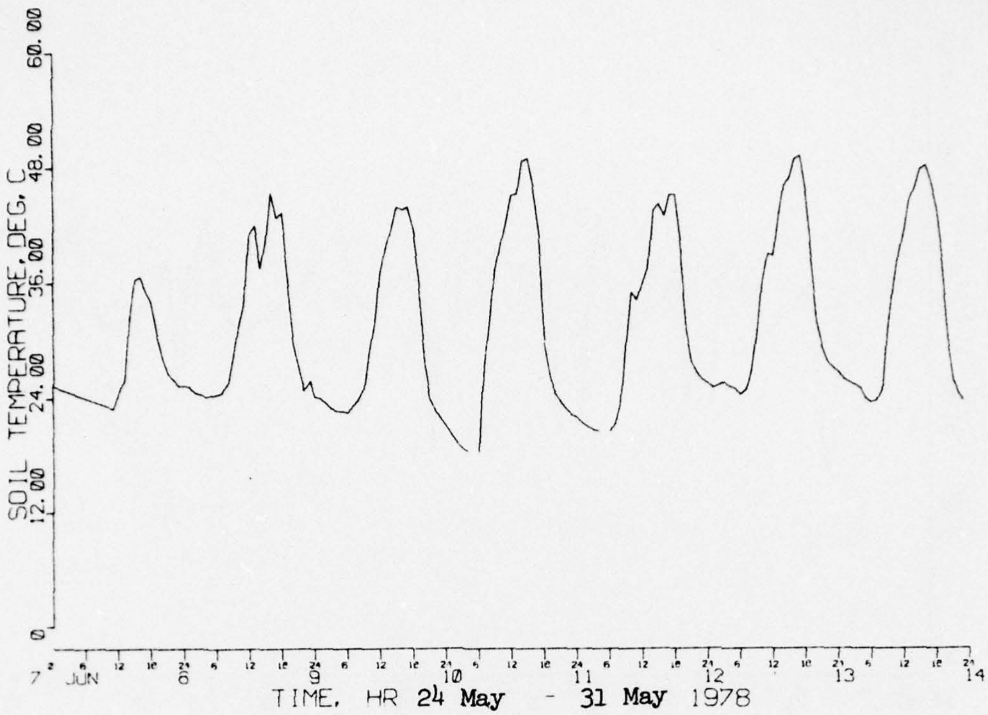
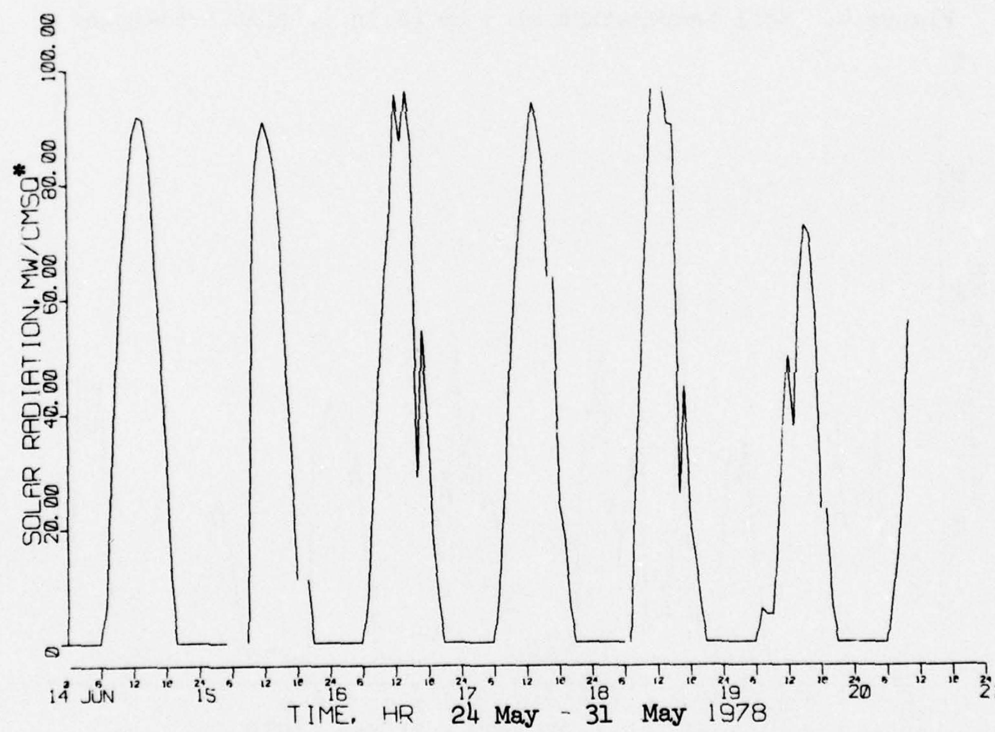


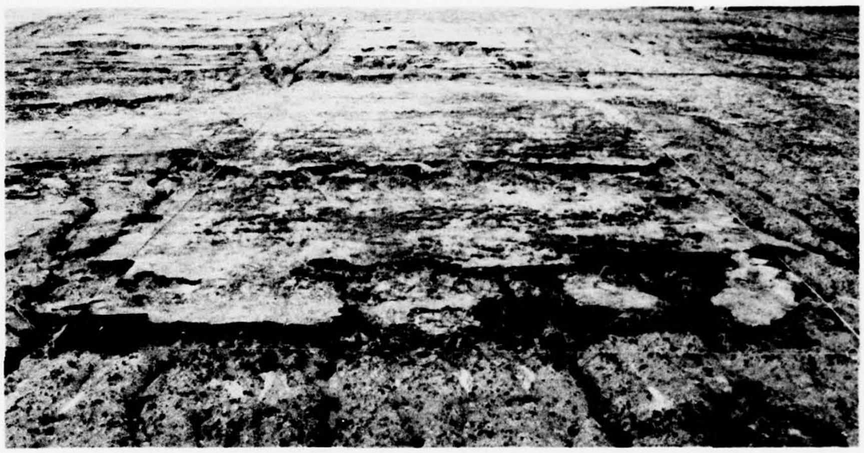
Figure 6. Soil surface temperature, plot B (sample)



* MW = milliwatts
CMSQ = square centimeter

Figure 7. Solar radiation 12 (sample)

a. 24 April

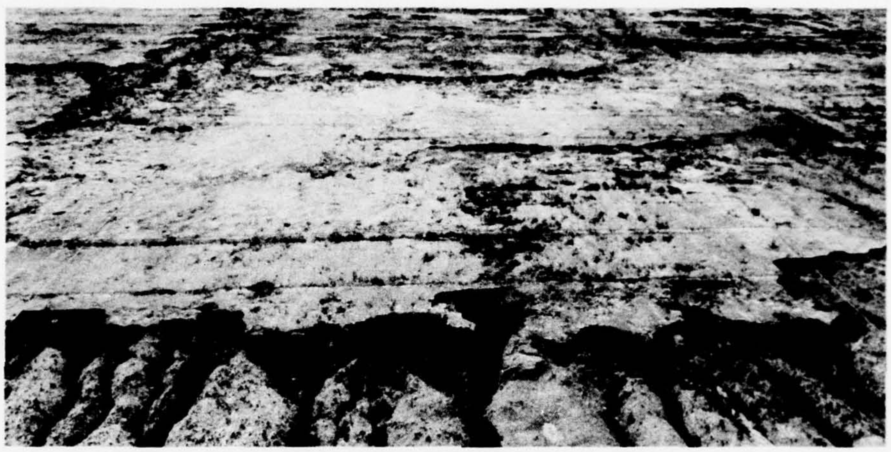


b. 11 May

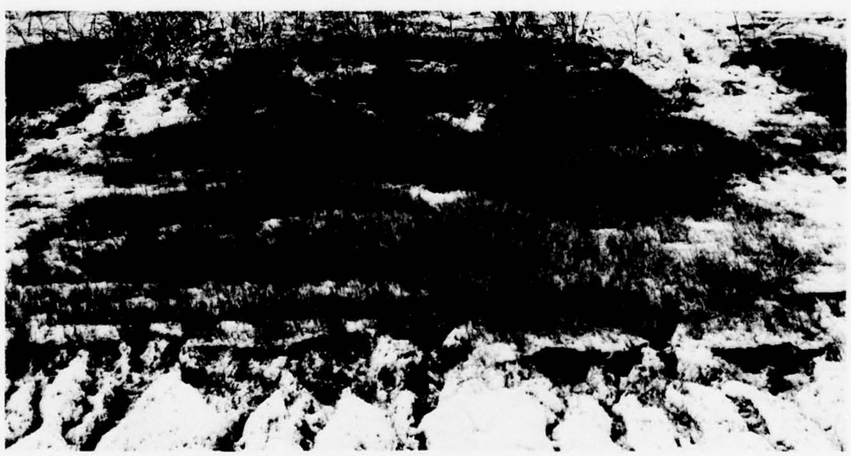
c. 22 June

Figure 8. Application of Aerospray-70 at rate of 0.122 ℓ/m^2 (130 gal/acre) on the slope (Section F_2)

a. 24 April



b. 11 May



c. 22 June

Figure 9. Application of Aerospray-70 at rate of 0.183 ℓ/m^2 (195 gal/acre) on the slope (Section G_2)

a. 24 April

b. 22 June

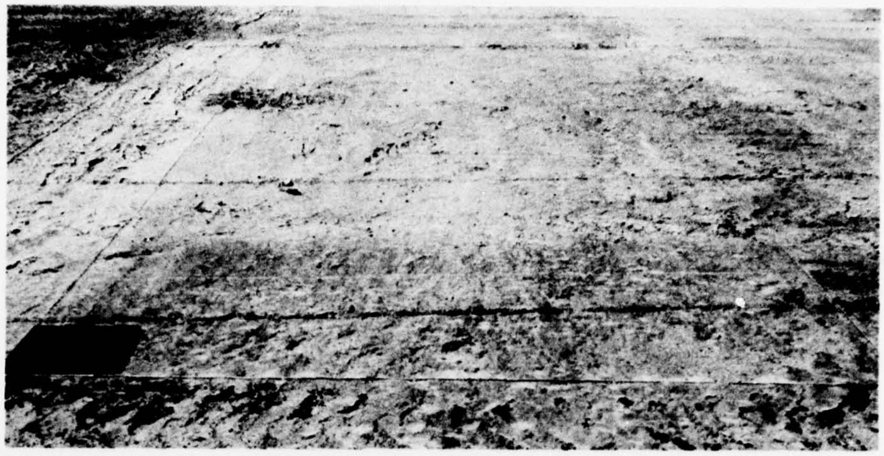
Figure 10. Application Aerospray-70 at rate of 0.122 ℓ/m^2 (130 gal/acre) on the flat area (Section B_3)

a. 24 April

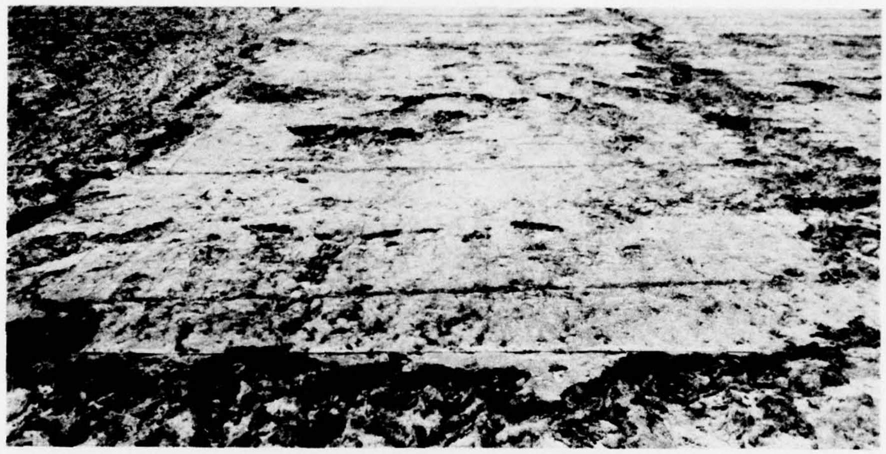
b. 11 May

c. 22 June

Figure 11. Application of Soil Seal at rate of $0.041\ \ell/m^2$ (45 gal/acre) on the slope (Section H_2)



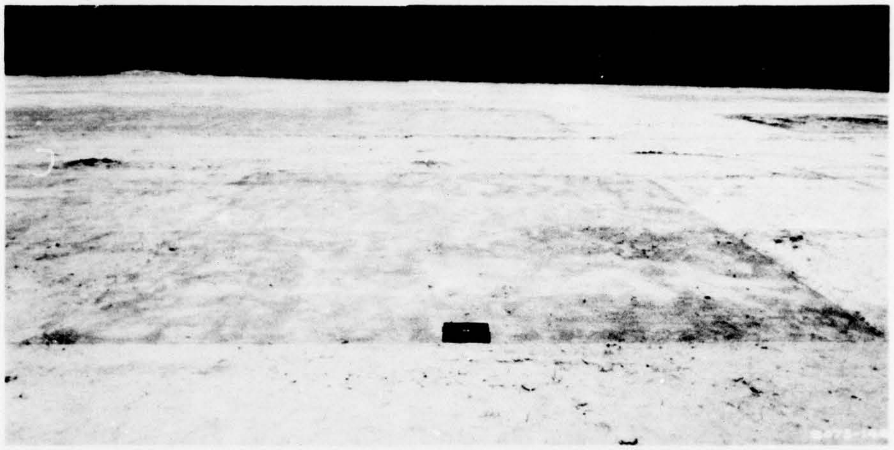
a. 24 April



b. 11 May

c. 22 June

Figure 12. Application of Soil Seal at rate of $0.061\ \ell/m^2$ (67.5 gal/acre) on the slope (Section I_2)



a. 24 April

b. 22 June

Figure 13. Application Soil Seal at rate of 0.041 ℓ/m^2 (45 gal/acre) on the flat area (Section C_3)

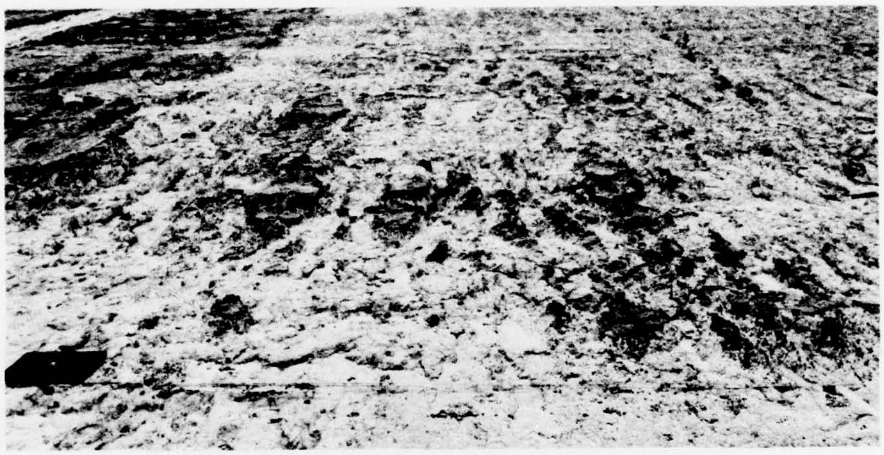
a. 24 April

b. 11 May

c. 22 June

Figure 14. Application of Nerozin at rate of $0.297\ \ell/m^2$ (320 gal/acre) on the slope (Section J_2)

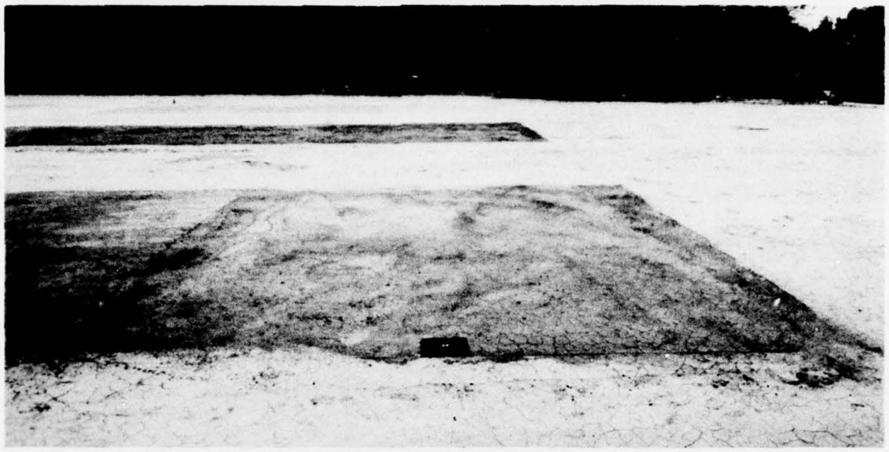
a. 24 April



b. 11 May

c. 22 June

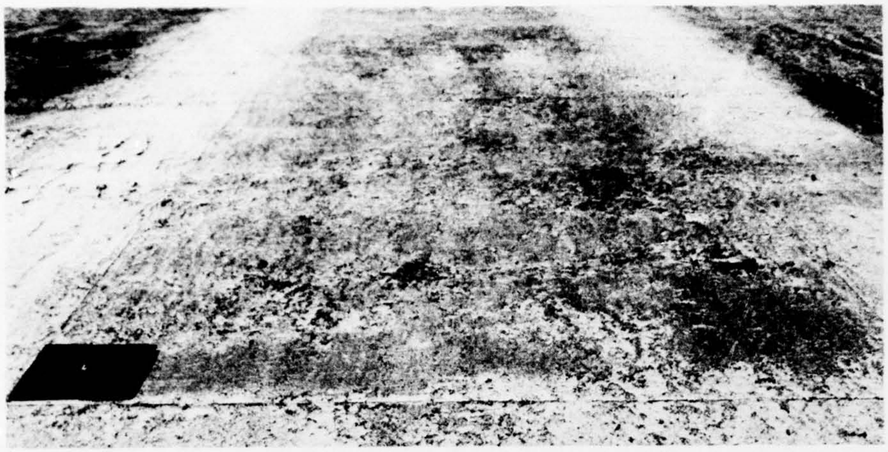
Figure 15. Application of Nerozin at rate of 0.448 ℓ/m² (480 gal/acre) on the slope (Section K_2)



a. 24 April

b. 22 June

Figure 16. Application of Nerozin at rate of 0.297 ℓ/m^2 (320 gal/acre) on the flat area (Section E_3)

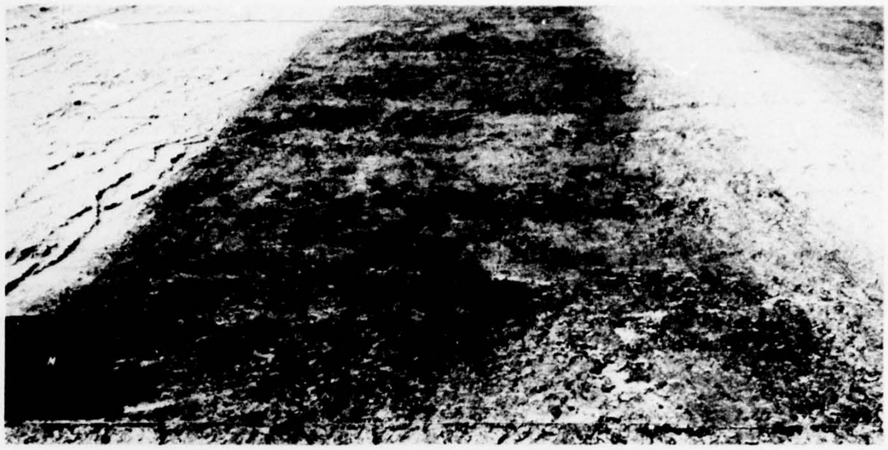


a. 24 April

b. 11 May

c. 22 June

Figure 17. Application of Peneprime at rate of 0.896 ℓ/m^2 (958 gal/acre) on the slope (Section L_2)

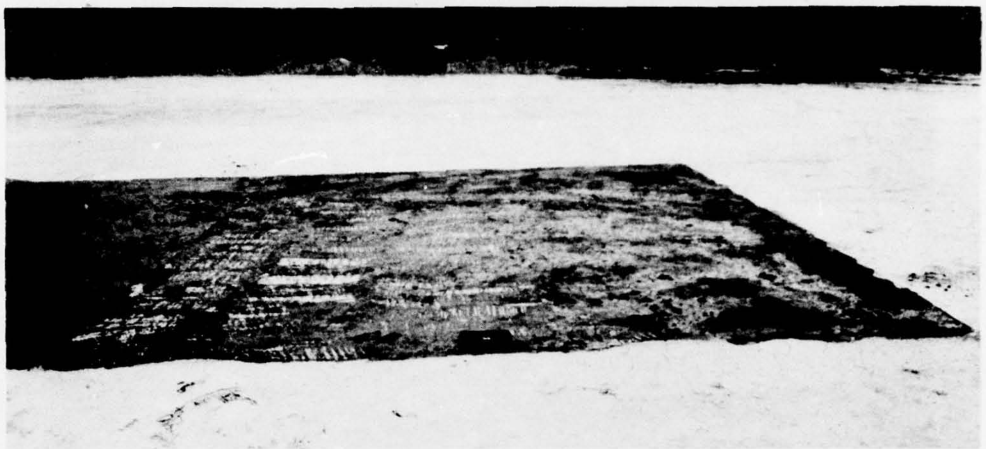


a. 24 April

b. 11 May

c. 22 June

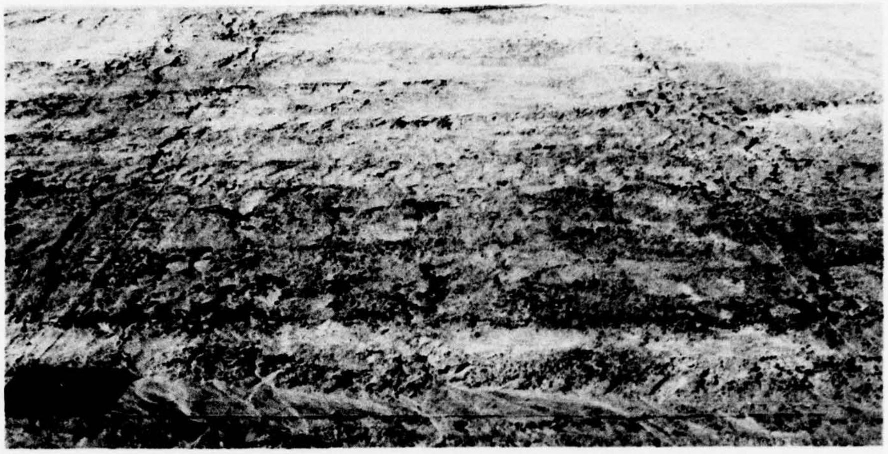
Figure 18. Application of Peneprime at rate of $1.344\ \ell/m^2$ (1437 gal/acre) on the slope (Section M_2)



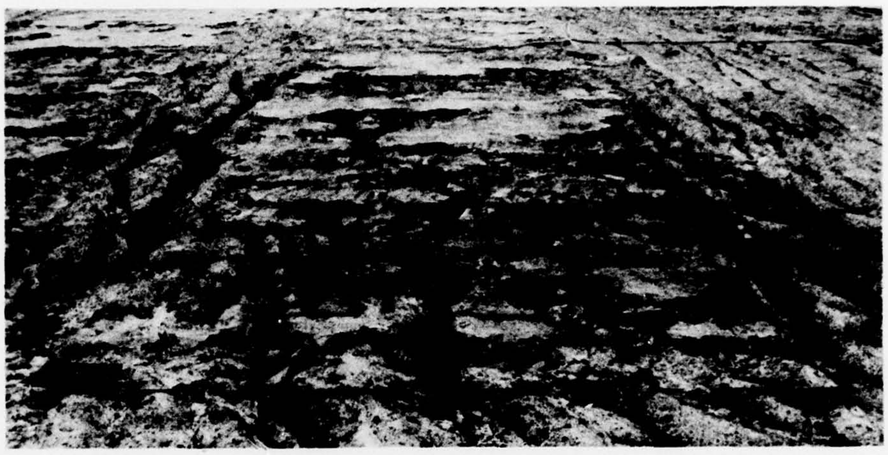
a. 24 April

b. 24 June

Figure 19. Application of Peneprime at rate of 0.896 ℓ/m^2 (958 gal/acre) on the flat area (Section D_3)



a. 24 April



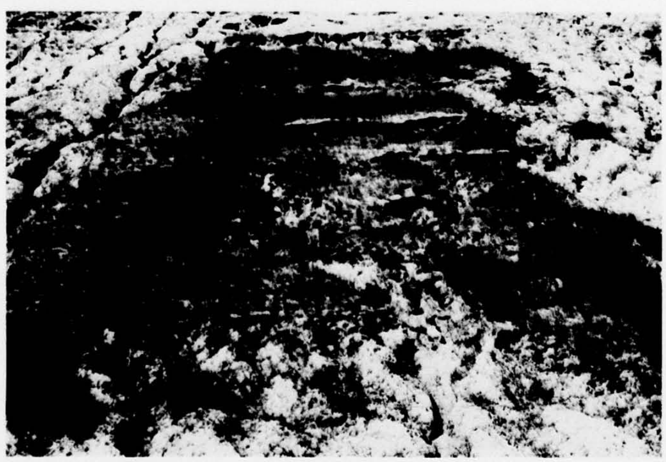
b. 11 May

c. 22 June

Figure 20. Application of DLR at rate of 0.041 ℓ/m^2 (45 gal/acre) on the slope (Section N_2)

a. 24 April

b. 11 May



c. 22 June

Figure 21. Application of DLR at rate of 0.061 ℓ/m^2 (67.5 gal/acre) on the slope (Section O_2)

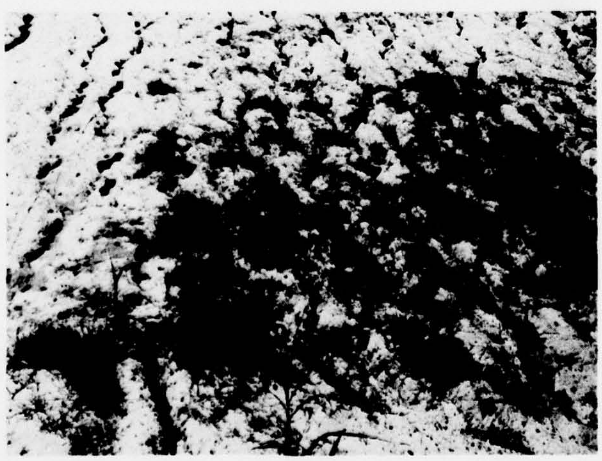
a. 24 April

b. 22 June

Figure 22. Application of DLR at rate of $0.041 \ \ell/m^2$ (45 gal/acre) on the flat area (Section Q_3)

a. 24 April

b. 11 May



c. 22 June

Figure 23. Control plot on the slope (Section P)

APPENDIX A: APPLICATION PROCEDURE

General

1. Both Aerospray-70 and Soil Seal can provide a surface coating that can vary from a tough continuous surface film to a light discontinuous film. The characteristics of the film depend primarily on the dilution and the application rate. In this investigation, the dilution and application rate found to be most effective and economical in reestablishing vegetation were:

Stabilizer	Dilution Stabilizer to Water	Application Rate ℓ/m^2	Application Rate gal/acre
Aerospray-70	1 to 10	.122	130
Soil Seal	1 to 10	.041	45

Equipment

2. When Aerospray-70 and Soil Seal are diluted 10 to 1 with water, the two materials approach a viscosity near that of water. This allows a wide latitude in the selection of spray equipment. Any equipment capable of producing a low-speed spray with uniform coverage will do an acceptable job. The equipment used should be determined by topography of the job site. Most equipment that is available for application of liquid fertilizers and insecticides is satisfactory. Hand-held equipment can be used for small jobs.

Clean Up

3. All equipment and tools should be cleaned with water immediately after exposure. Spray equipment should be flushed until water runs clear.

Notice

4. These products are temperature limited and should not be applied at temperatures below 4.4°C (40° F).

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